NEWS

MycoKey is playing a significant role in the context of solutions to tackle biological contamination of maize, wheat and barley in the food and feed chain, by applying an integrated approach to reduce the risks associated to toxigenic fungi and related mycotoxins, specifically aflatoxins, deoxynivalenol, zearalenone, ochratoxin A and fumonisins.

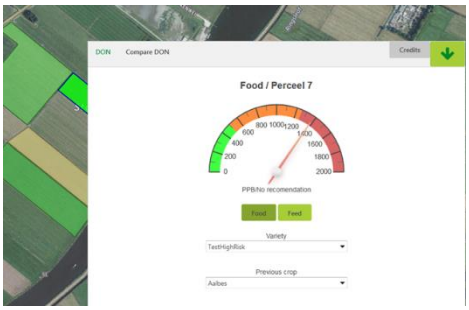
The 31 project partners are generating innovative and integrated solutions to support stakeholders in an effective and sustainable mycotoxin management along food and feed chains, to be applied both in Europe and in China. The MycoKey actions focus on three areas: a) **global knowledge and networking**, in particular with China, input for regulations; b) **innovative practical tools for farmers, end users and stakeholders** for mycotoxin monitoring and management, c) reliable **solutions**, sustainable **compounds**/green **technologies** in **prevention, intervention and remediation**. The developed methodologies and tools are targeted for cost-effective application in the field and during storage, processing and transportation, including alternative and safe ways to use contaminated batches.

With regard to **global knowledge and networking**, a series of round tables gathering international experts allowed to update scientific knowledge on the main topics of mycotoxin contamination**:** biodiversity, genomics as well as metabolomics of toxigenic fungi; advanced detection methods for mycotoxins, predictive modelling for toxigenic fungi and mycotoxins; emerging and modified mycotoxins, toxicity and regulation. This MycoKey global and multi-disciplinary scientific network has been involved in working groups on specific crops: maize, wheat & barley, grapes, nuts & dried fruits. In addition, the project is turning the scientific knowledge and tools developed during the first 36M of MycoKey into easy to understand messages for end users and stakeholders. To this scope, guidelines for mitigation of mycotoxin contamination in maize and wheat, lay summaries and papers to give scientific support and suggestions included in the guidelines, were prepared. The *MycoKey Charter* has been launched as a supporting tool to gather information and involve policy makers and stakeholders to define common actions to tackle mycotoxin contamination at the global level. These actions were conducted both in Ghent and Wuhan and will continue in Belfast in 2019.

The project is contributing to enhance the **dialogue with China**, where the parallel integrated research plan is being carried out by 11 Chinese partners and funded by MOST- Ministry of Science and Technology, thus going to achieve the objective of contributions to reduce the frequent and severe mycotoxin contaminations in crops.

A strong commitment by the project Coordinator and EU partners fed and boosted the process of cooperation with China , through participation at main institutional events and meetings. Chinese partners play relevant roles in all Work Packages and project's boards; they participated at the MycoKey training course in Europe, organised the successful 2nd MycoKey International Conference in Wuhan, hosted the Executive Committee meeting, the General Assembly as well as the round tables in 2018. They will organise a joint training course on food safety and an exploitation action with the Buhler group in 2019. Ten joint papers have been published so far, derived from different work packages on biodiversity of toxigenic fungi, mycotoxin detection and toxicology.

With regard to **innovative practical tools for farmers, end users and stakeholders** for mycotoxin monitoring and management, the **MycoKey app** represents a new integrated information system able to deliver information, links to tools and results/methods arising from the project activities to mitigate mycotoxin contamination. The MycoKey app was developed and integrated in the Akkerweb platform generated by Wageningen and partners. The app was presented and demonstrated during 7 international oriented workshops. The MycoKey app for cereals and maize will work globally and provides real-time and location-specific information on mycotoxin risks applying available mycotoxin risk models Both apps are currently free of charge and valorize weather data, satellite, sensor and science-based information for growers and other stakeholders for mitigation of mycotoxin risks. We are still working on the integration of Good Agricultural Practices (GAP) and customised advices. The tool will be used as a decision-making resource by stakeholders (e.g. growers, industry and food processers) to apply recommendations along the food and feed value chains.



MycoKey App

In the field of **mycotoxin monitoring**, MycoKey developed rapid, reliable and validated detection tools (kits) for toxigenic fungi and multi-mycotoxins for on-site application of the main chain/toxin combinations: Maize – AFLA, FUM, DON, ZEA; Wheat/Barley – DON, ZEA, OTA. In addition, analytical tools (kits) were developed for traditional and alternative sampling methods (grains and dust).
Regarding **toxigenic fungi and mycotoxin risks,** a new model for AFLA and FUM joint prediction in maize is now available, which will support maize chain operators in mitigation; an updated model for DSS on fungicide application to reduce DON in wheat is available for farmers (expected reduction of DON by 20%). Furthermore, an on-site living sensor application tool was developed for famers: field mates are currently operational in BE, NL and IT for wheat and maize, but can be extended to any field grown crop. The weather data are integrated via network of dBases to an IT-dashboard. A rapid LAMP assay for in-field detection of toxin producers for wheat and maize is available.
In addition, new rapid multi-toxin test kits are available and were validated to improve the process of management in food industries for food safety controls. These include a 3-myco DON/ZEA/FUM multiplex dipstick for maize, wheat and barley; a one-step multiplex strip test for AFB1/OTA/ZEA in maize, rice and peanuts; an aptameric multi-mycotoxin strip test; two fluorescence polarization immunoassay-based method for the simultaneous determination of DON and modified forms, for T2/HT2 and modified forms in wheat; and a real-time electrochemical profiling system for AFB1 in wheat and dried figs.
Four on-site dust sampling studies using the Rapidust® sampler were performed (two for maize and two for wheat). An LC-MS/MS method to provide data on multi-mycotoxin contamination in dust (and correlation with their content in maize and wheat) was developed, validated and applied to the analysis of maize, wheat and dust samples.
An assembly of novel toxicokinetic data for regulations on modified forms of DON, ZEA and AFB1 is currently finalised to improve process management of maize, wheat and barley. These data will contribute to l**egislation and standard settings** and a report for EFSA will be available by the end of 2019.

Reliable **solutions**, sustainable **compounds**/green **technologies** in **prevention, intervention and remediation** complete the contribution of the MycoKey project for the food safety.

In the field of **mycotoxin prevention**, the MycoKey solutions improve the breeding of less susceptible varieties/hybrids and the biological control of toxigenic fungi.
Highly tolerant varieties and hybrids were developed for **breeding and field test.** The identified commercial varieties and hybrids are promising with up to 70% DON reduction in soft wheat and, depending on the variety, with 30 to 60% DON reduction for durum wheat, while 13 promising maize hybrids with low levels of FER susceptibility and satisfactory grain yield resulted in 30 to 80% FUM reduction.

Regarding the use of biocontrol agents/ natural compounds/ resistance inducers as well as cropping measures, new insights were derived from the international research.

For example, AflaSafe II is a new line of a successfully marketed biopesticide assuring between 98% and 100% AFLA reduction in maize.
Furthermore, in Switzerland, a suitable inoculum production for the fungal antagonist *Clonostachys rosea* was successfully developed , resulting in 60% DON and 30% ZEA reduction in wheat.
To improve field management practices, several **new biological control agents** have been developed for Fusarium head blight (FHB) control in wheat. These include (local *C. rosea* strains (DON reduction between 69-85%); *Bacillus velezensis* RC 218 (DON reduction between 69 and 85%); *Streptomyces* spp. (DON reduction between 50 and 75%); and *Pseudomonas piscium* ZJU60 (biocontrol efficacy of 79%). In fact, *Pseudomonas piscium* ZJU60 and *Pantoea agglomeras* ZJU23 were comparable with chemical fungicides phenamacril or tebuconazole, respectively (biocontrol efficacy of 80%). In addition, mustard-based botanicals for control of *F. graminearum* in wheat showed a DON reduction from 75 to 100%.

In the field of **intervention**, innovative methods have been developed, such as novel fungicide compounds effective against FHB, allowing DON reduction of 90% in wheat, introducing a new generation fungicides for FHB control, as well as new EOW treatment in field showing 80-100% OTA production in grape.

In the field of **remediation, sustainable technologies for sanitation** of contaminated crops post-harvest are available. They include:

- Ozone generation against *Aspergillus flavus* and *Penicillium nordicum* growth during storage, leading to 100 % inhibition of *A. flavus* and *P. nordicum* development in grains in wheat and barley;
- New natural chemical device for the control of *A. flavus* and *P. verrucosum* in cereals during storage, with 72% OTA reduction in wheat and 92% in barley;
- Atmospheric Plasma Jet treatment on *A. flavus* in wheat, allowing a reduction of the fungal growth between 12 and 44%;
- UV treatments for the reduction of the *A. flavus* and *P. verrucosum* growth during storage, allowing significative reduction of toxigenic species (*P. verrucosum)* in green coffee, *A. flavus* in maize and walnuts.
- At industrial scale level, the combination of post-harvest **cleaning technologies** (mechanical and optical sorting) to be used by feed/food cereal processing industries significantly reduce contamination of mycotoxins in maize (AFLA: 60-90%, FUM: 65%, DON: 55%, ZEA: 100%).

New feed additives (multi-mycotoxins detoxifying agents) were developed to be potentially used by professionals in animal production and processing of animal food products; feed mills and feed additive producers. These feed additives were derived from two developed production processes, aimed to improve the efficacy of a yeast-based product in adsorbing ZEA (> 85%) , OTA and FB1 (>65%) (implementation and scale-up at industrial level), and to produce a new surface modified bio-organoclay aimed to reduce the *in vivo* bioavailabiliy of AFB1 , FB1, OTA, (> 90%) , and ZEA (> 70%) level in feed (maize and wheat). The *in vitro* efficacy of the developed multi-mycotoxin detoxifying agents was confirmed by toxico-kinetic studies with rats and pigs by using the biomarker approach.

Microbial and enzymatic detoxification. New enzymes/microorganisms as safe use options were developed**:**

- Bacterial strains for reduction of OTA in wine (41-60%) and DON in wheat grains (100%);
- Purified recombinant proteins / cloned bacteria (DON reduction: 50-70%) and Laccase enzyme purified from *Pleurotus* spp. (reduction of AFLA: 90%, ZEA: 100%, FB1: 40%, T-2: 40%)

Mushroom strains (Pleurotus eryngii, *Agaricus bisporum, Lentinula edodes*, *Cyclocybe aegerita*, *Hypsizygus tessellates* -Shimeij), (reduction of AFLA: 65-100 % of ; FB1: 67-100%, ZEA 91-100%)

- biogas production was not affected by mycotoxin contaminated grains as feeding substrate, and aflatoxins and FB1 were reduced by 90%. Bioethanol was efficiently produced in bioreactors with selected tolerant yeast strains from mycotoxin contaminated biomasses with good yields and productivities.